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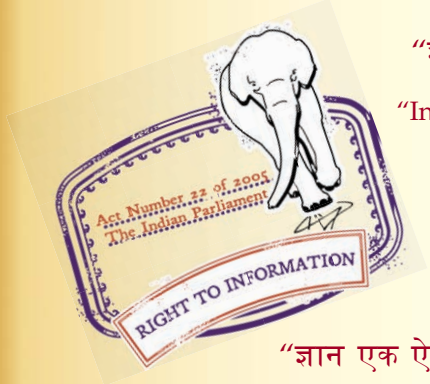

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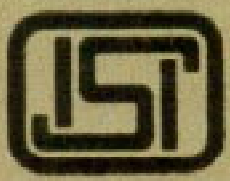
SPECIFICATION FOR CAPACITORS FOR RADIO INTERFERENCE SUPPRESSION

PART I GENERAL REQUIREMENTS AND METHODS OF TESTS

(First Revision)

UDC 621·319·4:621·396·669·8:620·1



INDIAN STANDARDS INSTITUTION
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SPECIFICATION FOR CAPACITORS FOR RADIO INTERFERENCE SUPPRESSION

PART I GENERAL REQUIREMENTS AND METHODS OF TESTS

(First Revision)

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Indian Standard

SPECIFICATION FOR CAPACITORS FOR RADIO INTERFERENCE SUPPRESSION

PART I GENERAL REQUIREMENTS AND METHODS OF TESTS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Part I) (First Revision) was adopted by the Indian Standards Institution on 5 May 1978, after the draft finalized by the Capacitors Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The object of this standard (Part I) is to lay down uniform requirements for the electrical, mechanical and climatic properties and safety requirements of radio interference suppression capacitors; to describe test methods and to specify preferred climatic categories according to their ability to withstand extremes of temperature, humidity, pressure or mechanical stress.

0.3 This standard was originally published in 1966. Subsequently methods of tests for all types of capacitors are grouped in IS : 7305 (Part I)-1973*. This standard is revised with a view:

a) to bringing it in line with latest IEC documents on capacitors for radio interference suppression; and IS : 7305 (Part I)-1973* which is a necessary adjunct to this standard;

b) to covering radio interference suppression capacitors intended for use on motor vehicles, in aircraft or for marine applications;

c) to reviewing the climatic categories, keeping in view the latest state of art;

d) to reviewing the schedule of type tests and number of samples required;

e) to reviewing the schedule of acceptance test, AQL values, and inspection levels; and

f) to improving certain performance requirements.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

0.4 Since the choice of capacitors for use either individually or in combination with other components for the purpose of radio interference suppression is governed by a number of factors including the type of equipment causing interference and various other considerations, some notes on the application of these capacitors are given in Appendix A for information and guidance.

NOTE — Attention is drawn to the fact that frequency conversion may take place within an electrical appliance giving frequencies higher than 100 Hz.

0.5 In preparing this standard assistance has been derived from the following:

IEC Document 40 (Sectt) 355 Sectional specification for fixed capacitors for radio interference suppression; Selection of methods of test and general requirements, issued by International Electrotechnical Commission.

JSS : 50213-1974 Detail specification for capacitors, fixed, radio interference suppression paper and plastic (foil and metallised dielectrics), issued by Directorate of Standardisation, Department of Defence Production, Ministry of Defence, New Delhi.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part I) covers capacitors for radio interference suppression, intended for apparatus and machines to be connected to supply mains of nominal voltage not exceeding 500 V dc or ac (rms) between conductors or 250 V do or ac (rms) between any one conductor and earth and a frequency not exceeding 100 Hz, and in such apparatus and machines where the capacitors may be directly connected with the supply mains.

1.2 This standard is applicable to capacitors used for interference suppression purposes, irrespective of the type of dielectric employed in the capacitor itself.

1.3 Combinations of two or more capacitors within one enclosure are also covered by this standard.

1.4 The capacitors of Class U (for 120 V mains operation) are not included in this standard since the nominal system voltage in India is 240 V.

*Rules for rounding off numerical values (*revised*).

2. TERMINOLOGY

2.0 For the purpose of this standard, the terms and definitions given in IS : 7305 (Part I)-1973* shall apply either modified or in addition to those given below.

2.1 AC Capacitor — A capacitor designed essentially for application with a power-frequency alternating voltage.

NOTE — AC capacitors may be used on dc supplies with the same rated voltage as the ac rms voltage.

2.2 DC Capacitors — A capacitor designed essentially for application with a direct voltage.

NOTE — DC capacitors may not be suitable for use on ac supplies.

2.3 Radio Interference Suppression Capacitor — A capacitor to be used for the reduction of interference at radio frequencies caused by electrical appliances.

2.4 Capacitor of Class X — A capacitor of a type suitable for use only in situations where failure of the capacitor would not lead to danger of electrical shock.

2.4.1 Class X capacitors are divided into three sub-classes according to the peak voltage of the pulses superimposed on the mains voltage to which they may be subjected to in service, and according to the required lifetime of the capacitor for its application. Such pulses may arise from lightning strikes on outside lines, from switching in neighbouring equipment, or switching in the equipment which is suppressed by the capacitor:

Sub-class	*Peak Pulse Voltage in Service*	*Application*	*Peak Pulse Voltage Up to Which Safety Requirements are Met*
X_1	>1 200	High pulse application; Normal life	4 000 when $C \leq 0{\cdot}33\ \mu F$ 4 000 exp $(0{\cdot}33 - C)$ when $C > 0{\cdot}33\ \mu F$
X_2	≤1 200	General purpose; Normal life	1 400
X_3	≤1 200	Intermittent use; Relatively short accumulated life	1 400

NOTE — Unless an application requires the use of either X_1 or X_2 capacitors, the X_3 class of this specification is regarded as being suitable for general purpose.

* Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

2.5 Capacitor of Class U or Y — A capacitor of a type suitable for use in situations where failure of the capacitor could lead to danger of electric shock.

NOTE — Differentiation of classes U and Y relates to supply voltages on which they are used.

Class U : For normal insulation requirements for countries where mains voltage up to 125 V are standard.

Class Y : For normal insulation requirements for countries where mains voltages greater than 125 V and up to 250 V are standard.

2.6 Two-Terminal Capacitor — A radio interference suppression capacitor having two terminals (*see* Fig. 1).

FIG. 1 TWO-TERMINAL CAPACITOR

2.7 Lead-Through Capacitor (Coaxial) — A capacitor with a central current-carrying conductor or a conductor connected with a current-carrying rod surrounded by a capacitor element which is symmetrically bonded to the centre conductor and to the outer electrode or casing to form a coaxial construction.

NOTE — It should be mounted coaxially (*see* Fig. 2).

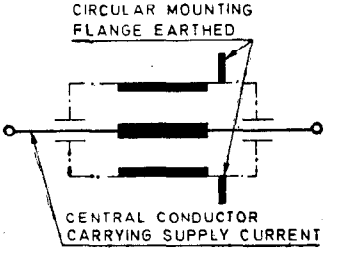
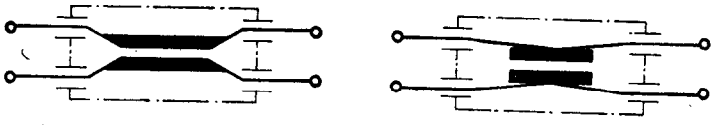


FIG. 2 LEAD-THROUGH CAPACITOR (COAXIAL)

2.8 Lead-Through Capacitor (Non-coaxial) — A capacitor in which the supply currents flow through or across the electrodes (*see* Fig. 3A, 3B and 3C).



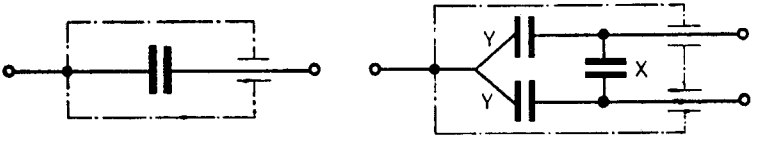
3A Lead-Through Capacitor for Symmetrical Use
(Non-coaxial)

3B Lead-Through Capacitor for Asymmetrical Use
(Non-coaxial)

3C Multiple Unit Lead-Through Capacitor (Non-coaxial)
for Symmetrical and Asymmetrical Use

FIG. 3 LEAD-THROUGH CAPACITOR (NON-COAXIAL)

2.9 By-Pass Capacitor — A capacitor where radio-frequency interference currents are by-passed to earth. There are two common forms, single and delta; the single capacitor employs a capacitor in an earthed metal case with one terminal connected to the case as in Fig. 4A, the delta form consists of an X-capacitor and two Y-capacitors arranged in a delta network as in Fig. 4B, the junction of the two Y-capacitors either being connected to the earthed metal case or brought out as a separate terminal.



4A Single By-Pass Capacitor 4B Delta By-Pass Capacitor

FIG. 4 BY-PASS CAPACITOR

2.10 Rated Voltage (U_R) — The rated voltage is either the rms operating voltage of rated frequency or the dc operating voltage, which may be applied continuously to the terminals of a capacitor at any temperature between the lower and the upper category temperatures.

NOTE — For capacitors covered by this standard, the category voltage is same as the rated voltage.

2.11 Upper Category Temperature — The maximum external surface temperature for which the capacitor has been designed to operate continuously.

NOTE — For lead-through capacitors the external surface temperature may be affected by internal heating due to the lead-through current. The terminals are considered to be part of the external surface.

2.12 Lower Category Temperature — The minimum external surface temperature for which the capacitor has been designed to operate.

2.13 Rated Temperature (of a Lead-Through Capacitor) — The maximum ambient temperature at which a lead-through capacitor may carry its rated lead-through current.

2.14 Insertion Loss (of a Radio Interference Suppressor) — The ratio of the voltage before and after the insertion of the suppressor as measured at the terminals.

2.15 Rated Current of the Conductor (Lead-Through Capacitor) — The rated current of the conductors is the maximum permissible current flowing through the conductors of the capacitor at the rated temperature during continuous duty operation.

2.16 Mains Resonant Frequency (Two-Terminal Capacitor) — The lowest frequency at which the impedance of the capacitor is a minimum when applying a sinusoidal voltage.

2.17 Safety Capacitor (for Protection Against Accidental Contact) — A capacitor of Class Y for connection (either directly or *via* other capacitors) between live parts and the chassis of the apparatus, the capacitance of which is so low that if a person simultaneously touches the apparatus and earth he will not have a hazardous current flowing through his body.

3. CLIMATIC CATEGORIES

3.1 The radio interference suppression capacitors covered in this standard are classified into climatic categories according to the general rules given in IS : 589-1961*.

*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

3.2 The capacitors covered by this standard shall belong to one of the preferred categories given in Table 1 based on their ability to withstand the climatic severities.

TABLE 1 CLIMATIC CATEGORIES

Sl No.	Climatic Test	Severities			
		Category 1		Category 2	Category 3
		A	B		
(1)	(2)	(3)	(4)	(5)	(6)
i)	Dry heat	+125°C	+85°C	+85°C	+70°C
ii)	Cold	−55°C	−55°C	−40°C	−10°C
iii)	Damp heat (long term)	56 days	56 days	21 days	10 days
iv)	Damp heat (accelerated)	6 cycles	6 cycles	2 cycles	1 cycle
v)	Rapid change of temperature	+125°C to −55°C	+85°C to −55°C	+85°C to −40°C	Not applicable
vi)	Low air pressure	4·4 kPa	4·4 kPa	8·5 kPa	60 kPa

Note — In cases where different combination other than those specified, is agreed, the severities for the cold, dry heat and damp heat (long term) tests shall be within the following ranges:

Cold	−10°C, −25°C, −40°C, −55°C
Dry heat	+70°C, +85°C, +100°C, +125°C
Damp heat (long term)	4, 10, 21, 56 days

The values selected within these ranges shall be chosen from those listed in the relevant tests of IS: 589-1961 'Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*). The severities for the cold and dry heat tests shall correspond to the lower and upper category temperatures respectively.

4. RATINGS

4.1 Rated Capacitance and Tolerances — The preferred rated capacitance values shall generally be selected from the E6 series of IS : 824-1965*. The maximum tolerances are ±20 percent, except for ceramic capacitors of Class X which may have a tolerance of −20/+80 percent.

Note — Where safety aspects of an equipment are considered in terms of leakage current, attention should be paid to the capacitance value and tolerance on it; and especially where ceramic capacitors are used, to the temperature and voltage characteristic of the capacitance.

* Preferred values for resistors and capacitors (*revised*).

4.2 Preferred Values of Rated Voltage — The preferred values of rated voltage are:

For ac capacitors: 50, 125, 140, 250, 380, and 440 V (rms).

For dc capacitors: 50, 160, 250, 500 and 630 V.

NOTE — Radio interference suppression capacitors would normally be chosen to have a rated voltage equal to, or greater than, the nominal voltage of the supply system to which they would be connected. It should, however, be borne in mind that the voltage of the system may rise by up to 10 percent above the nominal voltage.

5. CONSTRUCTION, FINISH AND WORKMANSHIP

5.1 The construction, finish and workmanship shall be in accordance with **5** of IS : 7305 (Part I)-1973*.

6. DIMENSIONS

6.1 The dimensions shall be as specified in the relevant detail specification.

7. MARKING

7.1 The following marking information in the order of importance given below is required:

a) Rated capacitance (may be indicated by the code given in IS : 8186-1976†);

b) Rated voltage and nature of supply (alternating voltage may be indicated by the symbol ~ and direct voltage by the symbol ⎓);

c) Indication of capacitor class;

d) Indication of the method of connection, if necessary;

e) Rated current of the conductor (in case of a lead-through capacitor);

f) Tolerance on rated capacitance (may be indicated by the code given in IS : 8186-1976†);

g) The symbol 'M' if the capacitor or a section of it is a metallized capacitor;

h) Manufacturer's name or trade-mark;

j) Style reference as given in relevant detail specification;

k) Indication of the appropriate category; and

m) Week or month and year of manufacture (this may be in the code form as given in IS : 8186-1976†).

7.2 The capacitor shall be clearly marked with as many as possible of the above items in the order given. The marking shall be sufficient to enable a clear identification of the component to be made.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

†Marking codes for values and tolerances of resistors and capacitors.

7.3 The package containing the capacitor(s) shall be clearly marked with all the information listed in **7.1**.

7.4 Any additional marking shall be so applied that no confusion may arise.

7.4.1 The capacitor or their package(s) may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI Marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

8. TESTS

8.1 Classification of Tests

8.1.1 *Type Tests*

8.1.1.1 *Type approval procedure* — The procedure for type approval shall be in accordance with IS : 2612-1965*.

8.1.1.2 *Number of samples* — Unless otherwise specified, the number of samples for each type shall be 30 (*see* Table 2).

8.1.1.3 The samples shall be representative of the range of capacitors for which approval is sought. This may or may not be the complete range covered by any detail specification. The sample shall consist of specimens having the lowest and highest voltage, and for these voltages the lowest and highest capacitance values. When there are more than 4 voltage ratings, an intermediate voltage shall also be tested. Thus for the approval of a range, testing is required of either 4 or 8 values (capacitance/voltage combinations). Where the total range consists of less than 4 values the number of specimens to be tested shall be that required for 4 values.

8.1.1.4 *Schedule of type tests* — The capacitors shall be subjected to the tests according to Table 2 and in the given order.

8.1.2 *Routine Tests* — The following tests shall be carried out on each capacitor:

a) Visual examination,

b) Voltage proof (as a flash test), and

c) Capacitance.

*Recommendation for type approval and sampling procedures for electronic components.

TABLE 2 SCHEDULE OF TYPE TESTS

(*Clauses* 8.1.1.2 *and* 8.1.1.4)

GROUP	NUMBER OF SAMPLES		TITLE OF TEST	CLAUSE REF
	Highest Voltage at Its Highest Appropriate Capacitance	Lowest Capacitance at Its Highest Appropriate Voltage		
(1)	(2)	(3)	(4)	(5)
0	15	15	Visual examination	**8.4.1**
			Dimensions	**8.4.2**
			Capacitance	**8.3.2**
			Tangent of loss angle	**8.3.3**
			Charge and discharge (where applicable)	**8.6.3**
			Radio-frequency suppression characteristics	**8.6.4**
			Voltage proof	**8.3.1**
			Insulation resistance	**8.3.4**
			Sealing	**8.6.1**
1	3	3	Solderability	**8.4.4.1**
			Robustness of terminations	**8.4.3**
			Bump	**8.4.6**
			Vibration	**8.4.5**
			Shock	**8.4.7**
			Acceleration (steady state)	**8.4.8**
			Rapid change of temperature	**8.5.3**
			Climatic sequence	**8.5.1**
2	3	3	Damp heat (long term)	**8.5.2**
3	3	3	Endurance	**8.6.2**
4	1	1	Mould growth	**8.5.4**
5	3	3	Resistance to solvents	**8.6.5**
			Resistance to soldering heat	**8.4.4.2**
6	1	1	Salt mist	**8.5.5**
SPARES	1	1		

8.1.3 *Acceptance Tests* — Two groups of samples (Group A and Group B) shall be selected (*see* Appendix B of IS : 2612-1966*) from the lot which have passed the routine tests and the capacitors in each group shall be subjected to the tests in Table 3 in the given order.

*Recommendation for type approval and sampling procedures for electronic components.

TABLE 3 SCHEDULE OF ACCEPTANCE TESTS

(*Clause* 8.1.3)

Test	Clause Ref	AQL* (Percent Defective)	Inspection Level*	*D*/*ND*
(1)	(2)	(3)	(4)	(5)
Group A Tests				
Insulation resistance Tangent of loss angle Insertion loss Sealing	**8.3.4** **8.3.3** **8.6.4** (b) **8.6.1**	1	II	*ND*
Group B Tests				
Sub-group B_1				
Robustness of terminations Solderability Bump (if required) Climatic sequence	**8.4.3** **8.4.4.1** **8.4.6** **8.5.1**	4	S3	*D*
Sub-group B_2				
Endurance (168 hours)	**8.6.2**	4	S3	*ND*

ND=Non-destructive *D*=Destructive

**See* IS : 2500 (Part I)-1973 Sampling inspection tables: Part I Sampling inspection by attributes and by count of defects (*first revision*).

8.2 General Conditions for Tests — The general conditions for tests shall be as specified in **7.2** of IS : 7305 (Part I)-1973* in addition to the following.

8.2.1 *Preconditioning* — Before starting the test programme all capacitors shall be preconditioned by the application of the rated voltage from a direct voltage source having low internal resistance such as a regulated power supply. The voltage shall be applied to the capacitor through a series resistor, the value of which shall be approximately 100 Ω for rated voltages up to and including 100 V and approximately 1 000 Ω for rated voltages above 100 V.

The voltage shall be maintained for one hour after its value across the capacitor has become equal to the rated voltage with a tolerance of ±3 percent. After this preconditioning the capacitors shall be discharged through a resistor of approximately 1 ohm per applied volt.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

The tests specified in **8.3** shall then be made after the capacitors have been stored for a period of 12 to 48 hours during which no voltage shall be applied. No further preconditioning as described above shall be applied during the test programme.

8.3 Electrical Tests

8.3.1 *Voltage Proof* — This test shall be carried out in accordance with **7.3.1** of IS : 7305 (Part I)-1973*, with the following additional details/modifications.

a) *Measuring condition* — The test voltage and test points shall be according to Table 4.

For type tests the voltage shall be applied for one minute. If this test is called for as a flash test (*see* **8.1.2**), the voltage shall be applied for two seconds with voltages in Table 4 increased by 10 percent.

For dc tests, the charging and discharging currents shall not exceed 0·05 A.

For dc tests, the time constant R_1 (C_1+C_X) shall not exceed one second.

For ac tests, the voltage shall be supplied from a transformer fed from a variable auto-transformer. The voltage shall be raised from near zero to the test voltage at a rate not faster than 150 V per second. The test time shall be reckoned from the time the test voltage is reached.

TABLE 4 TEST VOLTAGE FOR VOLTAGE PROOF TEST

Capacitors	Class	Between Terminations		Between Terminations Connected Together and the Case or Metal Foil Wrapped Over the Body
		Type Test	Routine Test	
(1)	(2)	(3)	(4)	(5)
AC	X (*see* Note 1)	4·3 U_R (dc)	4·3 U_R (dc) or 2·15 U_R (ac)	$2U_R$+1 500 V (ac) (*see* Note 2)
	Y	1 500 V (ac)	1 500 V (ac) or 2 250 V (dc)	$2U_R$+1 500 V (ac)
DC	X (*see* Note 1)	$3U_R$(dc)	3 U_R (dc)	$2U_R$+1 500 V (dc) (*see* Note 2)
	Y	2 000 V (dc)	2 000 V (dc)	$2U_R$+1 500 V (dc)

Note 1 — Not applicable to capacitors of rated voltage 50 V or less.

Note 2 — For delta capacitor units according to Fig. 4B the test voltage for terminals-to-case shall be the appropriate test voltage for the Y-capacitors.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

b) *Requirement* — During the test the capacitor shall not exhibit any permanent breakdown or flashover.

NOTE — Attention is drawn to the fact that repetition of the voltage proof test may damage the capacitor.

8.3.2 *Capacitance* — This test shall be carried out in accordance with **7.3.2** of IS : 7305 (Part I)-1973* with the following additional details/modifications:

a) *Measuring condition* — The measuring frequency shall be:

1 000 Hz for $C \leqslant 1$ μF
50 Hz for $C > 1$ μF

The measuring voltage shall not exceed the rated voltage. For ceramic capacitors the measuring voltage shall not exceed 1 volt. As the rated capacitance of ceramic capacitors as measured above is the small-signal capacitance, the manufacturer shall supply the following additional information for ceramic capacitors:

1) The maximum expected 50 Hz current through the capacitor at rated voltage, taking into account capacitance tolerance and temperature characteristic of capacitance.

2) The minimum expected capacitance taking into account capacitance tolerance, temperature characteristics of capacitance and (for dc rated capacitors) application of the full dc rated voltage.

NOTE — Where safety aspects of an equipment are considered in terms of leakage current, attention should be paid to the capacitance value and tolerance and; especially where ceramic capacitance are used to the temperature and voltage characteristic of the capacitance.

b) *Requirements* — The capacitance shall be within the rated tolerance.

8.3.3 *Tangent of Loss Angle* — This test shall be carried out in accordance with **7.3.3** of IS : 7305 (Part I) - 1973* with the following additional details/modifications:

a) *Measuring conditions* — Measurements shall be made as specified in **8.3.2** (a).

b) *Requirement* — The tangent of loss angle shall not exceed the value specified in the relevant detail specification.

8.3.4 *Insulation Resistance* — This test shall be carried out in accordance with **7.3.6** of IS : 7305 (Part I)-1973* with the following additional details/modifications:

a) *Measuring condition* — The measuring voltage shall be as specified in Table 2 of IS : 7305 (Part I)-1973* and applied to test points A and B or C.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

No special precautions are specified.

When measurements are carried out at temperatures other than 27°C the result shall be corrected to 27°C, where necessary, by multiplying the results of the measurement by an appropriate correction factor. In cases of doubt, measurement at 27°C is decisive.

NOTE — The correction factors which may be considered as an average for radio interference suppression capacitors are under consideration.

b) *Requirements* — The insulation resistance shall not be less than the values specified below:

Climatic Category (*See* **3.2**)	*Dielectric*	*Between Terminations*		*Between Terminations Connected Together and the Case or Metal Foil Wrapped Over the Body*
		When $C > 0{\cdot}33\ \mu F$	When $C \leqslant 0{\cdot}33\ \mu F$	
		RC (s)	R (MΩ)	R (MΩ)
1	Paper	4 000	12 000	12 000
	Plastic	10 000	30 000	30 000
	Ceramic	—	3 000	3 000
2 and 3	Paper	2 000	6 000	6 000
	Plastic	2 500	7 500	30 000
	Ceramic	—	3 000	3 000

NOTE 1 — In the above table, C is the rated capacitance and R the measured insulation resistance.

NOTE 2 — For dielectrics other than those stated above the detail specification shall define limits, where possible by reference to the appropriate Indian Standards.

NOTE 3 — For capacitors having one terminal connected to the case the insulation resistance limits measured between terminations shall be used.

NOTE 4 — For capacitors with a discharge resistor, measurement shall be carried out with the resistor disconnected. If the resistor may not be disconnected without the capacitor being destroyed then for routine tests the test may be omitted, but for type tests the manufacturer shall supply capacitors without discharge resistors.

8.4 Physical and Mechanical Tests

8.4.1 *Visual Examination* — The capacitor shall be visually examined for compliance with the requirements of marking, workmanship and finish.

8.4.2 *Dimensions* — The dimensions shall be checked for compliance with those specified in the relevant detail specification.

8.4.3 *Robustness of Terminations* — This test shall be carried out in accordance with **7.4.3** of IS : 7305 (Part I)-1973*.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

8.4.4 *Soldering*

8.4.4.1 *Solderability* — This test shall be carried out either by solder bath or solder globule method in accordance with **7.4.4** of IS : 7305 (Part I)-1973*, with the following additional details/modifications:

a) *Measuring conditions* — The wire terminals, stated by the manufacturer to be suitable for use with printed wiring, shall be so immersed that the distance between the normal mounting plane and the surface of the solder bath is $2^{+0}_{-0.5}$ mm using a heat shield of $1{\cdot}5 \pm 0{\cdot}5$ mm thickness.

The requirements for the solder globule method shall be prescribed in the relevant detail specification or shall be subject to agreement between the manufacturer and the purchaser.

Where neither the solder bath nor the solder globule method is appropriate the soldering iron test shall be used with soldering iron size A.

NOTE — The thermal shock test is not applicable.

b) *Requirements* — The terminations shall get wet easily and the tinning shall be uniform and good.

8.4.4.2 *Resistance to soldering heat* — This test shall be carried out in accordance with **7.4.4** of IS : 7305 (Part I)-1973*, without any predrying.

The capacitor shall be visually examined after recovery under standard measuring condition and there shall be no visible damage or leakage of sealing material and the marking shall be legible. The capacitance shall then be measured and change of capacitance value shall be within the limits specified in the relevant detail specification.

8.4.5 *Vibration* — This test shall be carried out in accordance with **7.4.5** of IS : 7305 (Part I)-1973* with the following additional details/modifications:

a) *Mounting* — The mounting shall be as prescribed in the relevant detail specification.

b) *Conditioning* — The severity shall be as specified in the relevant detail specification chosen from the following:

Frequency (Hz)	*Peak Value of Vibration Amplitude + 10 Percent*	*Duration*	*Climatic Category* (*See* **3.2**)
10-2 000	0·75 mm or 20 *g* whichever is less	12 hours	1 A
10-2 000	0·75 mm or 10 *g* whichever is less	9 hours	1 B and 2
10-500	0·75 mm or 10 *g* whichever is less	6 hours	3

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

c) *Measurement and requirements during testing* — Category 1 capacitors shall be loaded with rated voltage throughout the test. During the last half hour of vibration electrical measurements shall be made on the capacitors to determine intermittent faults (open or short circuits). It is desirable that the detecting equipment shall detect any interruption with a duration of 0·5 millisecond or greater. There shall be no interruption.

d) *Final inspection, measurements and requirements* — After the test the capacitors shall be visually examined and there shall be no mechanical damage. Marking shall be legible. The capacitance, tangent of loss angle and leakage current shall be measured. The variation shall be within the limits specified in the relevant detail specification.

8.4.6 *Bump* — This test shall be carried out in accordance with **7.4.7** of IS : 7305 (Part I)-1973* with the following additional details/modifications:

a) *Mounting* — The mounting shall be as prescribed in the relevant detail specification.

b) *Conditioning* — The degree of severity shall be:
   1) 4 000 bumps for category 1, and
   2) 1 000 bumps for categories 2 and 3.

c) *Measurements and requirements during testing* — Category 1 capacitors shall be loaded with rated voltage throughout the test. During the last half hour of vibration, electrical measurements shall be made on the capacitors to determine intermittent faults (open or short circuits). It is desirable that the detecting equipment shall detect any interruption with a duration of 0·5 millisecond or greater. There shall be no interruption.

d) *Final inspection, measurements and requirements* — After the test the capacitor shall be visually examined and there shall be no mechanical damage. Marking shall be legible. The capacitance, tangent of loss angle and leakage current shall be measured. The variation shall be within the limits specified in the relevant detail specification.

8.4.7 *Shock* — This test shall be carried out in accordance with **7.4.8** of IS : 7305 (Part I)-1973* with the following additional details/modifications:

a) *Mounting* — The mounting shall be as prescribed in the relevant detail specification.

b) *Conditioning* — The degree of severity shall be as specified in the relevant detail specification.

c) *Measurements and requirements during testing* — Category 1 capacitors shall be loaded with rated voltage throughout the test. During

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

the last half hour of vibration electrical measurements shall be made on the capacitors to determine intermittent faults (open or short circuits). It is desirable that the detecting equipment shall detect any interruption with a duration of 0·5 millisecond or greater. There shall be no interruption.

d) *Final inspection, measurements and requirements* — After the test the capacitor shall be visually examined and there shall be no mechanical damage. Marking shall be legible. The capacitance, tangent of loss angle and leakage current shall be measured. The variation shall be within the limits specified in the relevant specification.

8.4.8 *Acceleration* — This test shall be carried out in accordance with **7.4.9** of IS : 7305 (Part I)-1973*, with the following additional details/modifications:

a) *Mounting* — The mounting shall be as prescribed in the relevant detail specification.

b) *Conditioning* — The degree of severity shall be as specified in the relevant detail specification.

c) *Measurements and requirements during testing* — Category 1 capacitors shall be loaded with rated voltage throughout the test. During the last half hour of vibration electrical measurements shall be made on the capacitors to determine intermittent faults (open or short circuits). It is desirable that the detecting equipment shall detect any interruption with a duration of 0·5 millisecond or greater. There shall be no interruption.

d) *Final inspection, measurements and requirements* — After the test the capacitor shall be visually examined and there shall be no mechanical damage. Marking shall be legible. The capacitance, tangent of loss angle and leakage current shall be measured. The variation shall be within the limits specified in the relevant detail specification.

8.5 Climatic Tests

8.5.1 *Climatic Sequence* — The tests for climatic sequence shall be carried out in accordance with **7.5.1** of IS : 7305 (Part I)-1973* with the following additional detail modifications.

8.5.1.1 *Initial measurements* — The capacitance shall be measured.

8.5.1.2 *Dry heat* — This test shall be carried out in accordance with **7.5.1.2** of IS : 7305 (Part I)-1973*. Duration of the test shall be 16 hours unless otherwise specified in the relevant detail specification.

8.5.1.3 *Damp heat (accelerated) first cycle* — This test shall be carried out in accordance with **7.5.1.3** of IS : 7305 (Part I)-1973*.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

8.5.1.4 *Cold* — This test shall be carried out in accordance with **7.4.1.4** of IS : 7305 (Part I)-1973*. The duration of exposure shall be 2 hours unless otherwise specified in the relevant detail specification.

During the last 10 minutes of the period of exposure the rated voltage shall be applied to category 1 capacitors.

The capacitor shall remain under recovery condition for 2 to 4 hours. They shall then be removed from the recovery chamber and shaken by hand to remove droplets of water.

8.5.1.5 *Low air pressure* — This test shall be carried out in accordance with **7.5.1.5** of IS : 7305 (Part I)-1973* with the following additional detail modifications.

No initial measurements are required. Conditioning of capacitors shall consist of subjecting to an air pressure of 20 mbar for a period of 5 minutes the ambient temperature being between 15°C and 35°C. During the last minute of conditioning the rated direct voltage shall be applied. During and after tests there shall be no evidence of breakdown or flashover and no harmful deformation of the case.

8.5.1.6 *Damp heat (accelerated) remaining cycles* — This test shall be carried out in accordance with **7.5.1.6** of IS : 7305 (Part I)-1973*.

8.5.1.7 *Final inspection, measurements and requirements* — Within 1 to 2 hours after recovery the capacitor shall be inspected and measured and shall meet the requirements as follows:

Inspection or Measurements	*Inspection or Measuring Method*	*Requirements*
Visual examination	**8.4.1**	No visible damage. The marking shall be legible
Capacitance	**8.3.2**	The percentage difference between the capacitances measured finally and in **8.3.2** shall not exceed 5 percent
Tangent of loss angle	**8.3.3**	According to relevant detail specification
Insulation resistance	**8.3.4**	Insulation resistance shall be minimum 50 percent of the applicable values of **8.3.4**

8.5.2 *Damp Heat (Long Term)* — This test shall be carried out in accordance with **7.5.2** of IS : 7305 (Part I)-1973* with the following additional details/modifications:

a) *Measuring condition* — During the test, one-third of the lot of capacitors will be connected to a dc voltage equal to the rated voltage,

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

one-third to a dc voltage of 20 V and one-third without applied voltage.

b) *Final inspection, measurements and requirements* — Within 1-2 hours after recovery the capacitor shall be inspected and measured and shall meet the requirements as follows:

Inspection or Measurement	*Inspection or Measuring Method*	*Requirements*
Visual examination	**8.4.1**	No visible damage. The marking shall be legible
Capacitance	**8.3.2**	The percentage difference between the capacitances measured finally and in **8.3.2** shall not exceed 5 percent
Tangent of loss angle	**8.3.3**	According to relevant detail specification
Insulation resistance	**8.3.4**	Insulation resistance shall be minimum 50 percent of the applicable values of **8.3.4**

8.5.3 *Rapid Change of Temperature* — This test shall be carried out in accordance with **7.5.3** of IS : 7305 (Part I)-1973* with the following additional details/modifications:

a) *Measuring conditions* — Number of cycles 5
Duration of exposure at the temperature limits 30 minutes

b) *Requirements* — After recovery the capacitors shall be visually examined. There shall be no visible damage. The marking shall be legible. The capacitance, tangent of loss angle and insulation resistance shall be measured, and the change shall be within the limits specified in the relevant detail specification.

8.5.4 *Mould Growth* — This test shall be carried out in accordance with **7.5.4** of IS : 7305 (Part I)-1973*. There shall not be any mould growth visible to naked eye.

8.5.5 *Salt Mist* — This test shall be carried out in accordance with **7.5.5** of IS : 7305 (Part I)-1973*. The duration of exposure shall be 48 hours. There shall be no visible damage and marking shall be legible.

8.6 Miscellaneous Tests

8.6.1 *Sealing (Where Applicable)* — This test shall be carried out in accordance with **7.5.6** of IS : 7305 (Part I)-1973* with the following additional details/modifications.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

8.6.1.1 Plastic materials for outer containers shall be heat-resistant. The softening temperature shall be at least 10°C higher than the maximum rated temperature of the capacitor.

8.6.1.2 After the test, there shall be no evidence of leakage.

8.6.2 *Endurance* — This test shall be carried out in accordance with **7.9** of IS : 7305 (Part I)-1973* with the following additional details/modifications.

8.6.2.1 The sample for endurance tests shall be divided, if necessary, into three parts so that separate tests may be carried out on the X-capacitors, the Y-capacitors and the lead-through capacitors.

8.6.2.2 *Initial measurements* — No initial measurements shall be made.

8.6.2.3 *Class X-capacitors* — For multi-section capacitors all the X-sections shall be tested in parallel, if necessary, by short-circuiting and Y-sections.

The capacitors shall be subjected to the endurance test of 2 000 hours for category 1 capacitors and 1 000 hours for categories 2 and 3. The test voltage shall be 1·25 U_R except that for ac capacitors, once in each hour the voltage is increased to 1 000 V (rms) for 0·1 second. The test temperature shall be the upper category temperature.

The voltage shall be applied to each capacitor individually through a resistor of 470 $\Omega \pm 10$ percent. A suitable circuit for this purpose is given in Fig. 5.

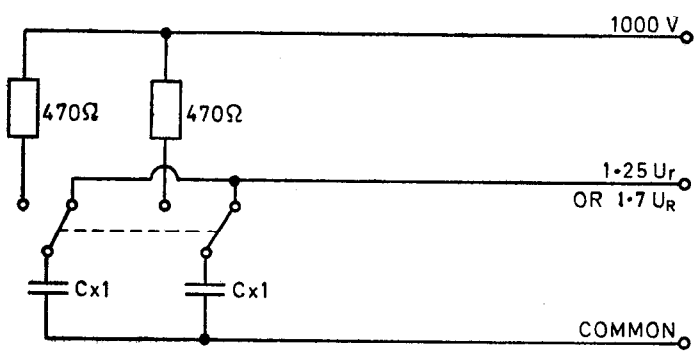


FIG. 5 ENDURANCE TEST

8.6.2.4 *Class Y-capacitors* — For multi-section capacitors all the Y-section shall be tested in parallel, if necessary, by shorting out any X-sections.

*Specification for fixed capacitors used in electronic equipment: Part I General requirements and tests.

The capacitors shall be subjected to the endurance test of 2 000 hours for category 1 capacitors and 1 000 hours for categories 2 and 3. The test voltage shall be 1·25 U_R except that for ac capacitors once in each hour the voltage is increased to 1 000 V(rms) for 0 1 second. The test temperature shall be the upper category temperature.

The voltage shall be applied to each capacitor individually through a resistor of 470 $\Omega \pm 10$ percent. A suitable circuit for this purpose is given in Fig. 5.

8.6.2.5 *Lead-through capacitors* — For lead-through capacitors all the lead-through wires shall be connected in series, and the capacitors submitted to an endurance test of 2 000 hours for category 1 and 1 000 hours for categories 2 and 3, with a current of 1·1 I_R passing through the lead-through wires.

The capacitors shall be mounted in the manner specified by the manufacturers and the oven shall be stabilized at the rated temperature, without current passing through the capacitors. The current then shall be switched on and the time counted from this moment.

After thermal stability has been re-established the core temperature of one of the capacitors shall be measured. It shall not exceed the upper category temperature.

8.6.2.6 *Final inspection, measurements and requirements* — The capacitor shall be considered to have failed when a short circuit occurs in any section of the capacitor or between any section and the case or between sections indicated by the blown fuse or when it does not meet the following requirements:

Inspection or Measurement	*Inspection or Measuring Method*	*Requirements*
Visual examination	**8.4.1**	No visible damage
Capacitance	**8.3.2**	The percentage difference between the capacitance measured finally and **8.3.2** shall not exceed ± 10 percent, or ± 20 percent for ceramic capacitors
Insulation resistance	**8.3.3**	Insulation resistance shall be minimum 50 percent of the applicable value in **8.3.4**
Insertion loss		According to relevant detail specification

8.6.3 *Charge and Discharge (Where Applicable)*

8.6.3.1 Tangent of loss angle shall be measured in accordance with **8.3.3**.

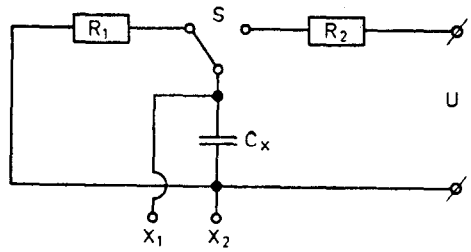
8.6.3.2 The capacitors shall be subjected to 10 000 cycles of charge and discharge at the rate of approximately one operation per second.

Each cycle shall consist of charging and discharging the capacitors.

For ac rated capacitors the test voltage shall be $\sqrt{2}\ U_R$ and for dc rated capacitor the test voltage shall be U_R.

Each capacitor shall be individually discharged through a resistor of such a value that the maximum discharge current shall be 100 V/μs.

A suitable circuit is given in Fig. 6.



C_x = capacitor under test
R_1 = discharge resistor
R_2 = charging capacitor
S = switch
U = charging voltage

NOTE — A self-healing process should not strongly deform the pulse shape. The test is designed to imitate the over voltage peaks as they can occur on power lines or by switching inductances.

FIG. 6 CIRCUIT FOR THE CHARGE AND DISCHARGE TESTS

8.6.4 *Radio-Frequency Suppression Characteristics* — The relevant detail specification shall give limits for one or more of the following radio-frequency characteristics as applicable:

a) Main resonant frequency of the capacitor,

b) Insertion loss,

c) Resistance at resonant frequency, and

d) The impedance of the capacitor and its inductance.

Appendix B gives suggested methods for determining these parameters.

NOTE — Because of the difficulty of the tests, these tests when called for should be carried out on two samples only.

8.6.5 *Resistance to Solvents* — This test shall be carried out in accordance with IS : 9000 (Part XX)-1979*.

*Basic environmental testing procedures for electronic and electrical items: Part XX Resistance to cleaning solvents and permanence of markings.

APPENDIX A

(*Clause* 0.4)

NOTES ON THE APPLICATION OF RADIO INTERFERENCE SUPPRESSION CAPACITORS

A-1. Electrical machines and apparatus may generate radio-frequency voltages which are fed back into the power supply mains. These radio-frequency disturbances may be picked up by apparatus connected to or placed close to the same power system up to a certain distance from the machines or apparatus.

A-2. The radio-frequency voltage may be generated both between conductors (phases) of the power system (symmetrical interference) and between conductors and earth (asymmetrical interference).

A-3. Radio interference can be suppressed by providing a low-impedance short-circuit path for radio-frequency currents at a place in the power supply close to the place where the radio-frequency voltages are generated. This may be combined with a high-impedance element which prevents the radio-frequency currents from penetrating into the power supply system, but has no appreciable effect on the flow of power current.

A-4. Some electrical apparatus requires for its operation a power supply voltage, free from radio interference to a greater extent than that guaranteed by the requirements. In that case, measures similar to those mentioned in **A-3** should be taken at a place in the power supply system close to the place where the apparatus is connected. When the apparatus is screened (or placed in a screened room), interference suppression will generally be applied at each point where the power supply system enters the screened enclosures.

A-5. Radio-interference suppression capacitors may be roughly divided into the following groups:

a) Two terminal capacitors, which may be connected to the machine, apparatus or supply system to provide for either symmetrical or asymmetrical interference suppression;

b) Combinations of capacitors (either combinations of separate capacitors or a multi-section capacitor, the sections of which may be connected in a certain manner), which may be connected to the machine, apparatus or supply system to provide for both symmetrical and asymmetrical interference suppression; and

c) Lead-through capacitors (asymmetrical or symmetrical) or combinations thereof, in which one or more sets or terminations are interconnected by means of a conductor intended to carry the power supply current. These capacitors are especially suited to provide interference suppression at the place where the supply system passes through a screen.

A-6. Symmetrical interference suppression is effected by connecting a capacitor between phases of the power supply (between phase and neutral for single phase power supply).

Asymmetrical interference suppression on machines or apparatus is in principle effected by connecting a capacitor from each phase (or phase and neutral) to earthed metallic parts or to the frame, metallic housing, etc, where this is not earthed. The suppression will often be more effective if the electrical parts of the apparatus are completely enclosed by the frame. Where the mains supply passes through a screen, asymmetrical interference suppression is in principle effected by connecting a capacitor from each phase (or phase and neutral) to the screen.

A-7. During operation, the capacitors are subjected to the supply mains voltage with a superimposed radio interference voltage.

In many cases, the extra load caused by the radio-frequency voltage is not important, but in other cases an appreciable radio-frequency current through the capacitor may occur or high-voltage peaks may be present. This must be taken into account when choosing the capacitor and a check should be made with the capacitor under its working conditions to make sure that the load on it is not more severe than had been anticipated.

A-8. The presence of inductance in the supply circuit in series with the capacitor may cause the voltage at power frequency applied to the capacitor to exceed the supply voltage.

A-9. In the case of failure by short-circuiting of capacitors connected between phases (or between phases and neutral), the apparatus will be duly disconnected by means of the normal short-circuit protection of the mains supply. For such capacitors a normal quality level is sufficient. They are indicated as Class X-capacitors.

A-10. In the case of failure by short-circuiting of capacitors connected between phases and accessible metal parts of the apparatus, the latter may become live with a dangerous voltage. From the safety point of view the dielectric strength of these capacitors must be at least equal to the dielectric strength of the insulation between live parts and accessible metal parts of the apparatus or system in which they will be used.

A-11. The power frequency current which can be drawn from accessible metal parts of machines or apparatus shall be so small as not to endanger human life and to limit any sensation of shock.

A-12. The voltage of a normal low voltage power supply mains fluctuates with time around the nominal value. This fluctuation is related with the daily load cycle of the mains, and the average voltage (for example, calculated over a 24-hour period) is a function of the place in the supply system. It may be assumed that the supply voltage will rarely exceed 110 percent

of the nominal voltage. On the other hand, the rated voltage of the capacitor is understood to be the voltage for continuous operation, whereas this voltage may be exceeded by 10 percent for part of the operating time. If this excess voltage is applied only for short period of each daily load cycle (for example, 1 hour per day) or for longer periods during some daily load cycles at irregular intervals it is not objectionable.

From this follows that in general, the rated capacitor voltage may be chosen equal to the rated supply voltage, unless a higher voltage at the capacitor terminals has to be expected (*see* **A-8** and **A-9**).

A-13. The effectiveness of interference suppression is a function of capacitor construction, mounting of the capacitor in the machine or apparatus, the radio-frequency voltage spectrum generated by the machine or apparatus, and of characteristics of the external unit.

A-14. Due to the complexity of the problem it is not possible to estimate with sufficient accuracy the radio-frequency characteristics. For this purpose the resonance frequency measured under given conditions and the radio-frequency resistance at resonance may in general be used. For these reasons it is not required that the radio-frequency characteristics be marked on the capacitor, nor has it been attempted to standardize certain value for these characteristics.

APPENDIX B

(*Clause* 8.6.4)

METHODS FOR DETERMINING RESISTANCE AT RESONANT FREQUENCY, CAPACITOR INDUCTANCE, COUPLING IMPEDANCE AND INSERTION LOSS

B-1. RESISTANCE AT RESONANT FREQUENCY

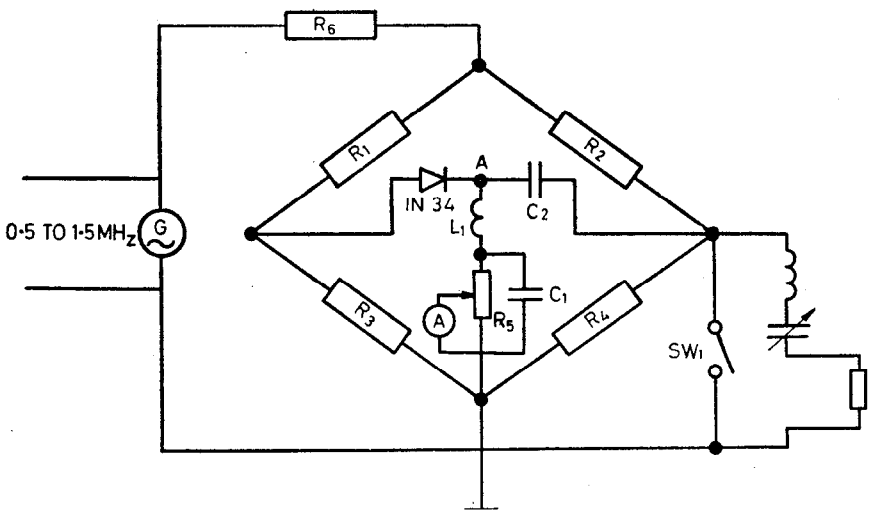
B-1.1 The rapid and accurate measurement of radio-frequency resistance of electronic components, such as capacitors, inductors and r.f. resistors, is frequently necessary as a production test or laboratory measurement. Users frequently find it necessary to test for r.f. resistance as part of their incoming inspection programme.

B-1.2 A production test unit for the rapid measurement of r.f. resistance either on a limit basis or a measurement basis is described below. Although the test set was specially designed for capacitors, it will serve just as well for inductors and r.f. resistors.

B-1.3 The circuit consists basically of a balanced arm Wheatstone bridge with one arm shunted by the test piece as shown in Fig. 7. The input signal is supplied by an oscillator having a frequency range of 0·5 to 1·5 MHz and a power output of 25 W.

B-1.4 The absolute values of resistance in the bridge arms are not critical. However, the values in each pair are closely matched. The values of R_1 and R_2 are each about 3 ohms but matched within 0·1 percent. Similarly R_3 and R_4 are each about 7 ohms, also matched within 0·1 percent.

B-1.5 The *IN* 34 germanium diode and blocking capacitor are used so that the voltage at point A will be unidirectional. The voltage is zero when the bridge is balanced with the test piece out of the circuit. With the test piece connected or R_4 short-circuited by *SW* 1, the bridge is unbalanced and a dc voltage exists at A. The value of this voltage is a measure of resistance of the bridge test arm, and therefore, of the resistance shunting R_4.



$R_1 = 3\Omega$ $R_6 = 10\Omega$ 10W
$R_2 = 3\Omega$ $C_1 = 0{\cdot}01\ \mu F$
$R_3 = 7\Omega$ $C_2 = 0{\cdot}01\ \mu F$
$R_5 = 10\ 000\Omega$ 25W $L_1 = 3$ mH

Circuit diagram of bridge test set for r. f. resistance. Test piece circuit shunts R_4. Unbalance voltage at A gives indication of resistance value. A d. c. microammeter is used.

NOTE — This test set may be modified for high-speed testing by using a motor-driven variable capacitor and an oscilloscope. The shunt reactance may then be passed through zero periodically at a rapid rate and the indicated resistance will also pass through its lowest value at the same rate. This will be shown through by the luminous trace on the oscilloscope, and the operator can easily determine if the maximum deflection falls within specified limits, especially if a long persistance phosphor is used in the cathode-ray tube.

FIG. 7 CIRCUIT FOR MEASURING RESISTANCE AT RESONANT FREQUENCY

B-1.6 Point A is connected to earth through a 10 000 ohms potentiometer with a 0·100 dc microammeter connected from the sliding tap to grouped as shown in the figure. The deflection of the meter gives a measure of the dc voltage at A, and therefore, the value of the resistance of the test piece at the test frequency. The series inductor and the shunt capacitor are used to reduce the ac ripple current through the potentiometer R_5.

B-1.7 The plug-in coil and variable capacitor in series with the test piece are used so that the overall reactance (capacitance and inductive) shunting R_4 is zero at the test frequency. Thus, only the tare resistance of the plug in coil, capacitor, and lead wires plus the resistance of the test piece remain.

B-1.8 The plug-in coil and variable capacitor are selected so that the overall reactance, including that of the test piece, may be adjusted to zero within the range of the variable capacitor. Because of variations in each unit tested, the variable capacitor is adjusted to indicate the lowest resistance on the motor. The tare resistance shall, of course, be subtracted from the indicated resistance. It is determined by connecting the test terminals together and adjusting the capacitor for lowest resistance as in the usual test procedure. Tests on a limit basis may be made in about 2 seconds and absolute measurements in about 4 seconds.

B-1.9 The test set is calibrated in the following manner. The switch $SW1$ is closed to short-circuit R_4 and the tap of R_5 is adjusted to adjust the meter pointer to zero ohms. Then various known value of r.f. resistance, such as straight lengths of resistance wire or r.f. resistors, are connected in the test position and the corresponding deflections of the meter noted. It is important to maintain the same lengths and positions of lead wires during calibration and in all testing.

B-2. CAPACITOR INDUCTANCE IN THE RANGE 6 TO 18 MHz

B-2.1 A circuit suitable for testing the capacitor inductance in the range of 6 to 18 MHz is given in Fig. 8.

B-2.2 Operation Sequence — The operation is performed in the following sequence:

a) Adjust oscillator to desired frequency by manipulating capacitor C_1.

b) Place shorting link across terminals X and adjust calibrated variable capacitors C_5 and C_6 to the maximum deflection of meter A.

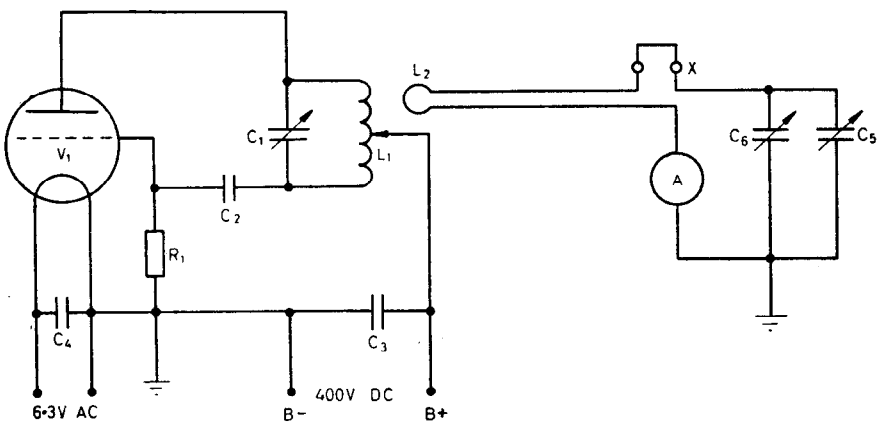
c) Determine tare inductance L_t equivalent to L_2, the meter A and connections by calculations from the capacitance C_5 and C_6 and the operating frequency.

d) Insert capacitor at terminals X and rebalance C_5 and C_6 for maximum deflection on meter A.

e) From new reading of capacitance C_5 plus C_6 determine new inductance. Where the test capacitor is large in comparison to C_5 plus

C_6 the inductance of the unknown capacitor is determined by subtracting tare inductance (L_t) from the inductance of the circuit with the test capacitor connected.

f) When the test capacitor is of the same order of capacitance as C_5 plus C_6, the effective capacitance (C_2) of the test capacitor and the calibrated variable capacitor in series must be calculated. From this calculated capacitance determine the inductance of the circuit (L_0) including the test capacitor. The inductance of the test capacitor is $L_0 - L_t$.



V_1 = 812 triode
L_1 = 5 microhenry tank coil 3·2 mm diameter copper tube
L_2 = 0·25 microhenry coupling coil 3·2 mm diameter copper tube
C_1 = 20 — 200 pF variable capacitor, 1·5 mm spacing
C_2 = 390 pF mica capacitor 2 500 V
C_3 = 390 pF mica capacitor 2 500 V
C_4 = 0·01 pF 630 V mica capacitor
C_5 = 20 — 2 200 pF variable capacitor
C_6 = 5 — 140 pF midget variable capacitor
R_1 = 10 000 ohm 5 watt wire-wound resistor
A = 0 — 5 A thermocouple ammeter
X = terminals for insertion of test capacitor

FIG. 8 CIRCUIT FOR TESTING THE CAPACITOR INDUCTANCE

B-2.3 Coupling Impedance — Under consideration.

B-3. INSERTION LOSS

B-3.1 The insertion loss of a filter capacitor connected into a given transmission system is defined as the ratio of voltage appearing across the line immediately beyond the point of insertion, before and after insertion. In the practical 50-ohm test circuit the insertion loss is given by the ratio of

signal generator input voltages required to maintain constant output voltage, with and without the capacitor in the circuit. The ratio is expressed in decibels (dB) as:

$$\text{Insertion loss} = 20 \log_{10} \frac{E_1}{E_2}$$

where

E_1 = output voltage of signal generator with capacitor in the circuit, and

E_2 = output voltage of signal generator with capacitor not in the circuit.

B-3.1.1 The test circuit shall be arranged as shown in Fig. 9.

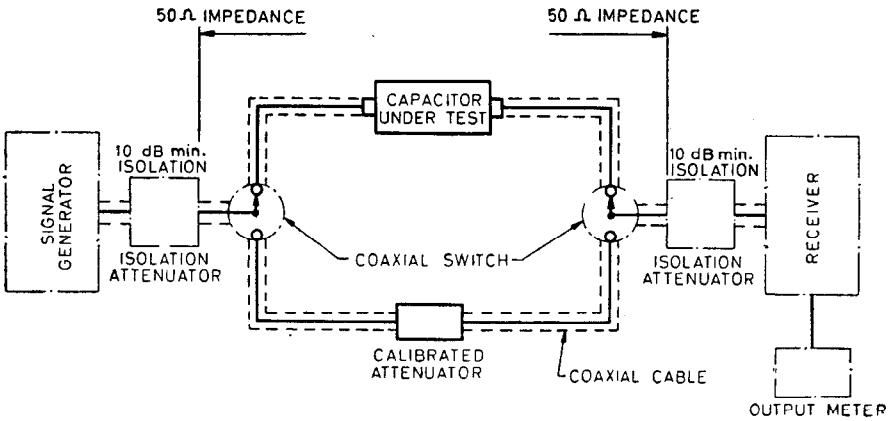
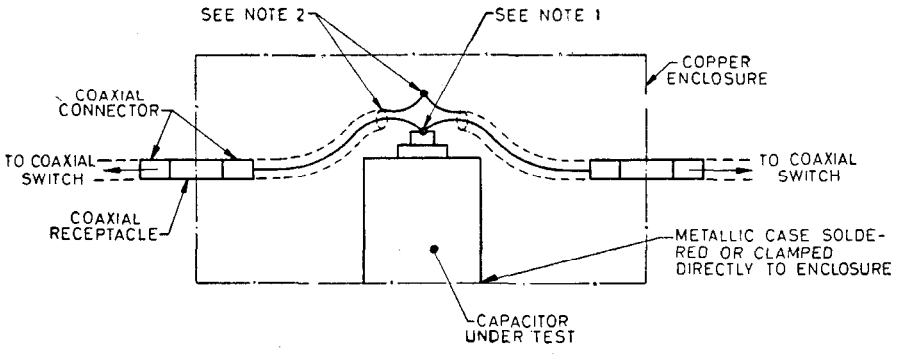


FIG. 9 TEST CIRCUIT FOR MEASUREMENT OF INSERTION LOSS

B-3.2 The method of mounting and connecting to the capacitor under test will depend on the type of unit. In general, three types will be encountered:

a) One type is a two-terminal network in which the metallic case of housing constitutes a common or ground terminal. The method of mounting and connecting for this type shall be as shown in Fig. 10.

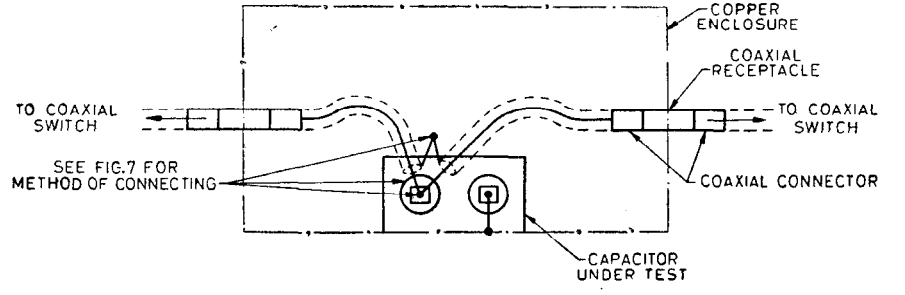
b) A second type is a two-terminal network in which the case does not constitute one of the terminals of the capacitor. The method of mounting and connecting for this type shall be as shown in Fig. 11.



NOTE 1 — Exposed portion of coaxial cable centre conductor shall be as short as possible. Outer shielding shall be connected together with as short a lead as possible.

NOTE 2 — If capacitor terminal is fixed, coaxial cable centre conductors shall be connected directly to the terminal. If capacitor terminal is a wire lead, the length of this lead between the capacitor case and the junction with the coaxial cable centre conductors shall be specified as part of the test conditions. The length chosen should be as short as feasible.

FIG. 10 METHOD OF MOUNTING AND CONNECTING TWO TERMINAL CAPACITOR (WITH CASE AS ONE TERMINAL)



NOTE — If capacitor terminal is fixed, it shall be connected to the copper enclosure by a 20 gauge solid copper wire, the length of which shall be specified as part of the test conditions. The length chosen should be as short as feasible. If capacitor terminal is a wire lead, this lead shall be connected to the enclosure by as short a length as possible and this length shall be specified as part of the test conditions.

FIG. 11 METHOD OF MOUNTING AND CONNECTING CAPACITOR WITH TWO TERMINALS

B-3.3 The test procedure shall be as follows:

The coaxial switches shall be set to the capacitor in position. The signal generator shall be adjusted to the desired frequency with its attenuator set for the lowest convenient value of output voltage. The receiver shall be tuned to resonance at the frequency of the generator and the gain controls shall be set so that the sensitivity is great enough and the level of circuit noise low enough to allow clear reception of the signal requires for the measurement. The output of the signal generator (E_2) shall be adjusted to give the lowest possible stable and readable indication on the output meter, care being taken not to saturate or overload the receiver. The receiver shall be returned to resonance and the calibrated attenuator adjusted until the output meter gives the same indication as that obtained for the capacitor in condition. The insertion loss of the capacitor under the specified conditions and at the frequency of measurement in then read from the calibrated attenuator.

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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Printed at Sree Saraswaty Press Limited (Under Govt. of India Management) Calcutta, India